# NANOTECHNOLOGY:

## A Department of Defense (DoD) Perspective, and an Overview of Environmental Safety and Occupation Health (ESOH) Policy Issues


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# Outline

- National Nanotechnology Initiative (NNI) Overview and DoD Perspective
- DoD Nanotechnology Goals
- NEHI Working group and research needs
- Request for Nanotechnology POCs
- Backup slides
  - Nanotechnology Act of 2003/Technology Centers
  - NSET Program Component Areas
  - ESOH Applications
  - Nanotechnology References

# DoD Perspective: Nanotechnology and the NNI

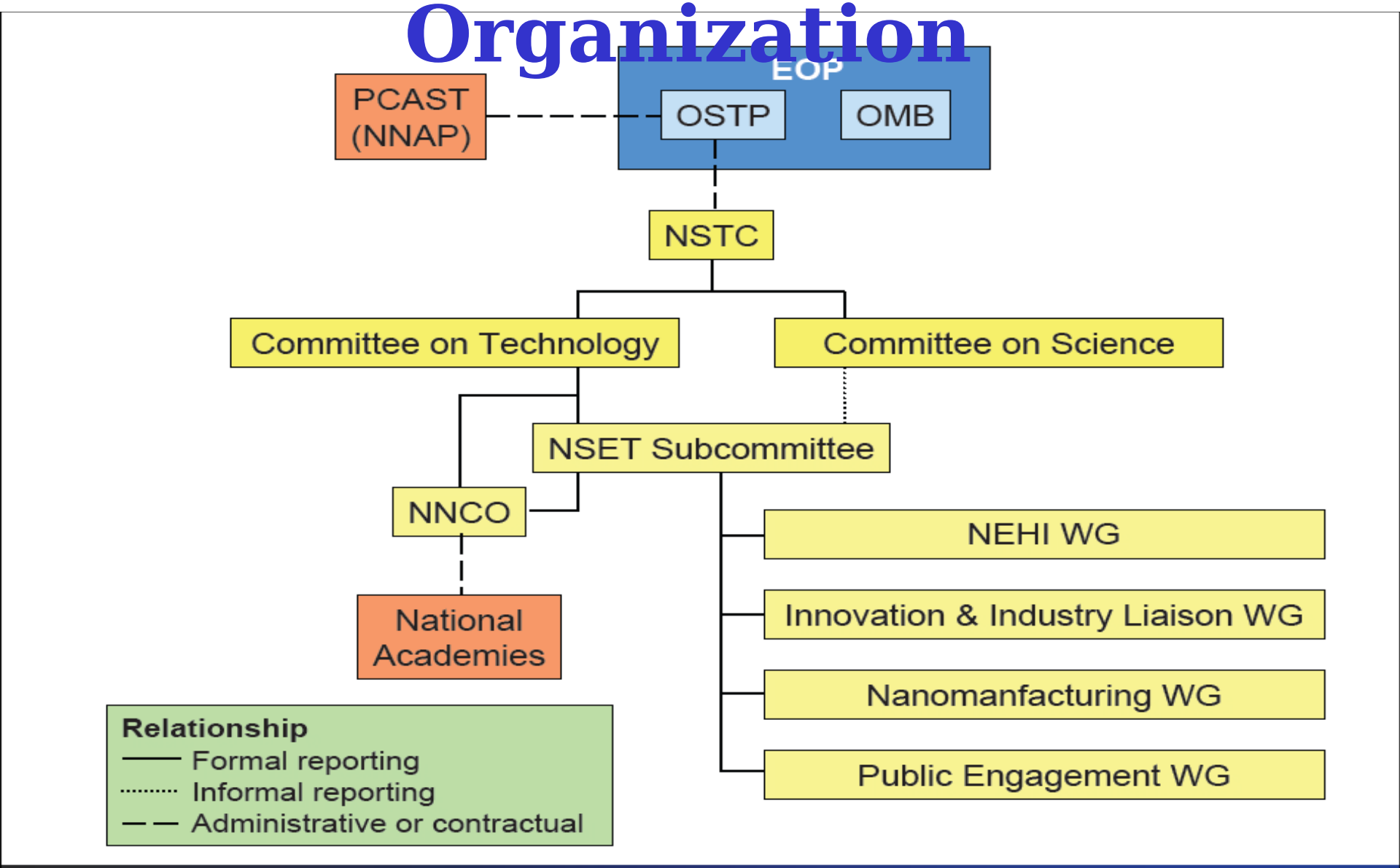
**"Uniquely" Department of Defense:**

- **Simultaneous focus on scientific merit and potential relevance to DoD:**
  - **<u>Scientific Merit:</u> to develop understanding and control of matter at dimensions of approximately 1 to 100 nanometers, where the physical, chemical, and biological properties differ in fundamental and valuable ways from those of individual atoms, molecules, or bulk matter**
  - **<u>Relevance to DoD:</u> to discover and exploit unique phenomena at these dimensions to enable novel applications enhancing war fighter and battle systems capabilities**
- **History of major support for pre-"nano" nanotechnology research**
- **No additional or specific DoD appropriations for nanotechnology or NNI**
- **NNI accelerates high-potential nanotechnology-based capabilities:**
  - **Chemical/biological defense; Information technology; Energy and energetics; Multifunctional materials and devices; Health monitoring and sensing**
- **"Hierarchical" coordination and collaborations**

# DoD Nanotechnology Goals & Metrics

- Opportunity-driven and needs-driven research to enhance war fighter and battle systems capabilities
- Agency Working Groups
  - DoD Agency Reliance Panels
  - OSD Nanoscience Strategic Research Area (SRA) Committee
    - (Chair: Dr. Dr. Gernot Pomrenke, Air Force Office of Scientific Research)
  - Army RDECOM Nanotechnology Integrated Product Team
    - (Chair: Dr. Michael Sennett, Natick Soldier Center)
  - Naval Working Group on Nanoscience
    - (Chair: Dr. James Murday, Naval Research Laboratory)
  - Air Force NanoScience and Technology Working Group
    - (Chair: Dr. Daniel Miracle, Air Force Research Laboratory)
- Subcommittee on Nanoscale Science, Engineering, And Technology (NSET)

# NNI Organization



# Programmatic Alignment towards NNI Strategic Goals

- NNI Goals [NNI Strategic Plan December 2004]:
  - Maintain a world-class research and development program aimed at realizing the full potential of nanotechnology
  - Facilitate transfer of new technologies into products for economic growth, jobs, and other public benefit
  - Develop educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology
  - Support responsible development of nanotechnology
- Program Component Areas (PCAs):
  - Fundamental Nanoscale Phenomena and Processes
  - Nanomaterials
  - Nanoscale Devices and Systems
  - Instrumentation Research, Metrology, and Standards for Nanotechnology
  - Nanomanufacturing
  - Major Research Facilities and Instrumentation Acquisition
  - Societal Dimensions

# NEHI Working Group

**Nanotechnology Environmental Health Implications (NEHI) Working Group of NSET:**

- **Several Federal agencies and departments represented, including:**
- *NSF/FDA* **Co-chairs,** *OSHA, EPA, NIH/NIEHS, CPSC, NCI, CDC/NIOSH*, **Defense, Energy, Agriculture, others**
- **Note: Italicized Agencies have a primary ESOH research function. DoD/DOE may have most users and thus potential exposure.**
- **Dr. Randall Cramer is formal DoD NEHI Rep randall.cramer@navy.mil, (301) 744-2578**
- **Group has identified many Nanotechnology ESOH questions, few answers**

# NEHI Research needs

- 9 Primary (unpublished) ESOH Research needs identified:
  - Nomenclature
  - Analytical techniques
  - Exposure, Fate and Transport
    - Workplace, Environment, Consumer Products
  - Exposure management
  - Physiology/toxicology (dose/response)
  - Epidemiology/population studies –
  - Life Cycle Assessment
  - Risk Assessment (modify procedures for nano)
  - Inventory of materials
- These similar to needs Identified by EPA in White Paper

# Wanted – DoD POCs

- There is daily information on applications and implications of NT, done by Academia, Federal labs, Private sector, other nations.
- Tracking/sharing information/comments is critical
- Military application POCs - ARO/Dr. Stepp, others
- ESOH Applications/Implications?
  - DoD MERIT, others?
  - Army CHPPM/AEC/AEPI/ODEP/ERDC/RDECOM, ?
  - Other service reps?
- Let us know:
  - Who you are/ areas of interest
- Goal:  Develop network of HQ and field personnel sharing information on latest nanotechnology developments, publications, meetings, etc

# Any Questions, Contact:

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# 21st Century Nanotechnology Research & Development Act of 2003

- Signed by the President on Dec. 3, 2003
- Put into law ongoing activities
- Authorized $3.7 billion in FY2005-FY2008 among 5 agencies
- "Established" a National Nanotechnology Coordination Office
- Calls for periodic planning and reporting by the NSET Subcommittee
- Calls for the President to establish or designate a National Nanotechnology Advisory Panel
- Calls for a triennial review by the National Research Council

One Hundred Eighth Congress
of the
United States of America

AT THE FIRST SESSION

*Begun and held at the City of Washington on Tuesday, the seventh day of January, two thousand and three*

An Act

To authorize appropriations for nanoscience, nanoengineering, and nanotechnology research, and for other purposes.

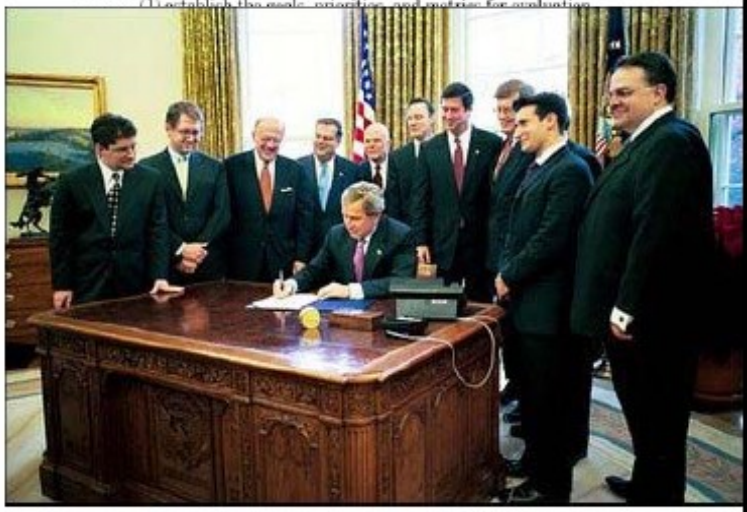
*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

**SECTION 1. SHORT TITLE.**

This Act may be cited as the "21st Century Nanotechnology Research and Development Act".

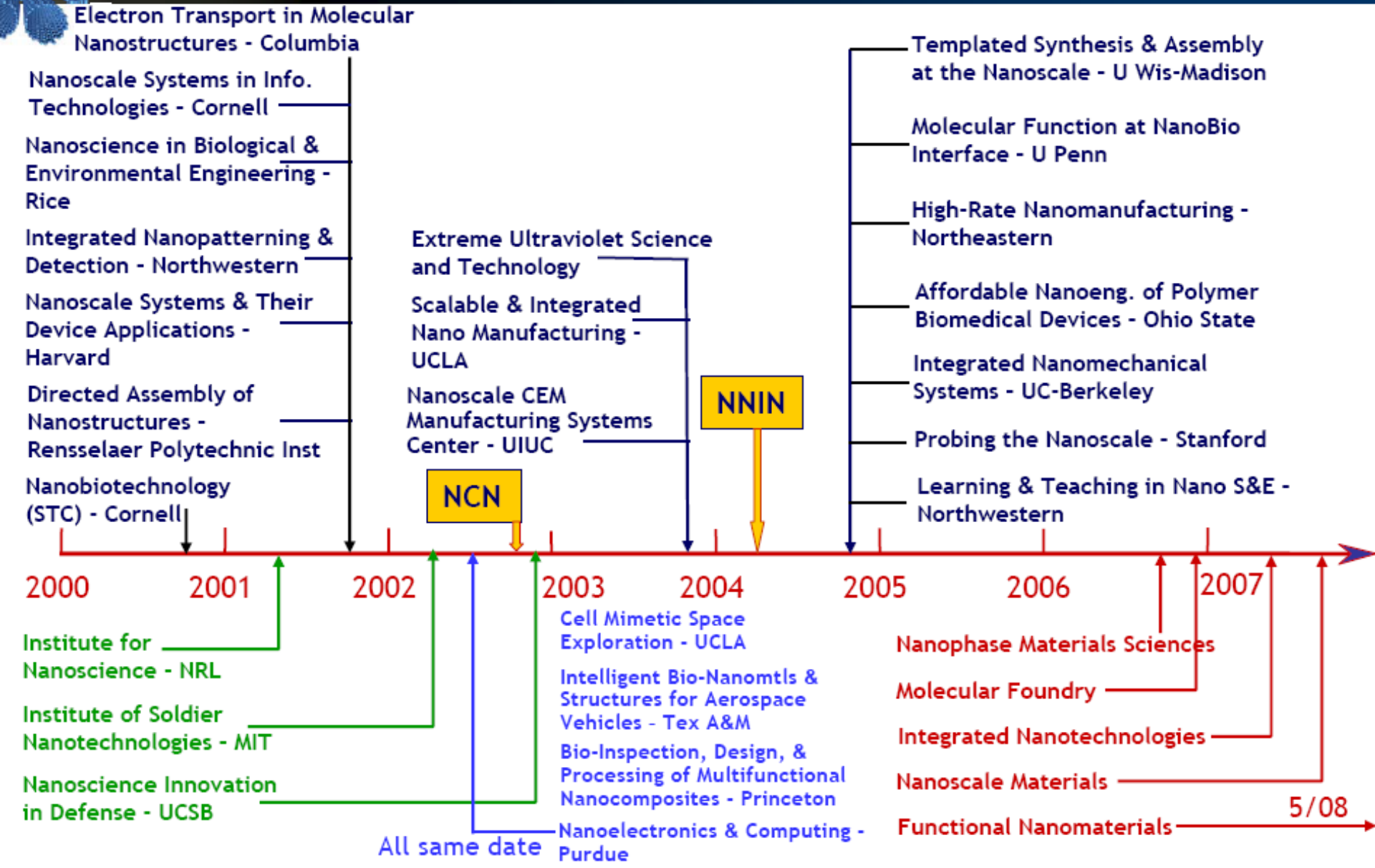
**SEC. 2. NATIONAL NANOTECHNOLOGY PROGRAM.**

(a) NATIONAL NANOTECHNOLOGY PROGRAM.—The President shall implement a National Nanotechnology Program. Through appropriate agencies, councils, and the National Nanotechnology Coordination Office established in section 3, the Program shall—



NATIONAL NANOTECHNOLOGY INITIATIVE

# Strong, Growing Infrastructure of Centers and User Facilities


Electron Transport in Molecular Nanostructures - Columbia
Nanoscale Systems in Info. Technologies - Cornell
Nanoscience in Biological & Environmental Engineering - Rice
Integrated Nanopatterning & Detection - Northwestern
Nanoscale Systems & Their Device Applications - Harvard
Directed Assembly of Nanostructures - Rensselaer Polytechnic Inst
Nanobiotechnology (STC) - Cornell
Extreme Ultraviolet Science and Technology
Scalable & Integrated Nano Manufacturing - UCLA
Nanoscale CEM Manufacturing Systems Center - UIUC
NCN
NNIN
Templated Synthesis & Assembly at the Nanoscale - U Wis-Madison
Molecular Function at NanoBio Interface - U Penn
High-Rate Nanomanufacturing - Northeastern
Affordable Nanoeng. of Polymer Biomedical Devices - Ohio State
Integrated Nanomechanical Systems - UC-Berkeley
Probing the Nanoscale - Stanford
Learning & Teaching in Nano S&E - Northwestern
2000
2001
2002
2003
2004
2005
2006
2007
Institute for Nanoscience - NRL
Institute of Soldier Nanotechnologies - MIT
Nanoscience Innovation in Defense - UCSB
All same date
Cell Mimetic Space Exploration - UCLA
Intelligent Bio-Nanomtls & Structures for Aerospace Vehicles - Tex A&M
Bio-Inspection, Design, & Processing of Multifunctional Nanocomposites - Princeton
Nanoelectronics & Computing - Purdue
Nanophase Materials Sciences
Molecular Foundry
Integrated Nanotechnologies
Nanoscale Materials
Functional Nanomaterials
5/08

# Nanoscale Science, Engineering, And Technology (NSET)

# Program Component Areas (PCAs)

# Fundamental Nanoscale Phenomena and Processes

- **DoD Program Goals Include:**
  - **To discover new phenomena and processes to enable breakthrough advantages for warfighter and battle systems capabilities**
  - **To develop robust strategies for synthesis, characterization, and assembly of individual nanostructures**
  - **To explore applications of nanostructures for revolutionary catalysts, scavengers, taggants and sensors**
  - **To elucidate fundamental aspects of phonon and electron transport in individual nanowires and two and three dimensional nanostructures as they relate to the development of high performance thermoelectric, thermionic, and photovoltaic devices for advanced solid state power generation, cooling, and thermal management**

# Nanomaterials

- **DoD Program Goals include:**
  - **To develop precision nanostructure synthesis techniques required to provide process control over quantum transport characteristics of devices utilizing nanostructured materials**
  - **To harness biological processes for low-cost synthesis and templating of designed nanostructures**
  - **To control and exploit interactions between synthetic and naturally-occurring (biological) materials**
  - **To develop nanoscale architectures to enhance local diffusion behavior, reaction kinetics, optical properties, and electrical properties**

# Nanoscale Devices and Systems

- **DoD Program Goals include:**
- **To utilize breakthroughs in nanotechnology to provide revolutionary devices and systems to advance war fighter and battle systems capabilities**
- **To establish a detailed understanding of nanoscale behavior related to electrochemical power source applications (batteries with enhanced discharge rate and energy density, high energy density capacitors, etc.), fuel cell catalysts, and electrode structures**
- **To engage the DoD applied research and development communities to accelerate the transition of science discovery into DoD relevant technologies**
- **To work with the Director, Defense Research and Engineering (DDR&E) Advisory Group on Electron Devices (AGED), US Navy groups developing technology plans for Navy Carrier Technology (CARTECH), Navy Submarine Technology (SUBTECH), and Navy Surface Technology (SURFTECH) programs, the Air Force Future Technology Branch, and the U.S. Army Research, Development and Engineering Command (RDECOM) Nanotechnology Working Group to examine future platform opportunities and requirements**

# Instrumentation Research, Metrology, and Standards for Nanotechnology

- **DoD Program Goals Include:**
  - **To develop breakthrough next-generation instrumentation for developing advanced nanotechnology-based materials and devices**
  - **To extend magnetic force microscopy and enable robust single spin measurement devices**
  - **To extend new measurement capabilities into innovative sensors for use in defense missions**

# Nanomanufacturing

- **DoD Program Goals include:**
  - **To guide and monitor the introduction of nanotechnology into military hardware**
  - **To identify appropriate opportunities to introduce nanomanufacturing into the DoD Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR) and Manufacturing Technology (MANTECH) programs**
  - **To enable the synthesis, generation, and assembly of individual nanostructures using lessons drawn from biology, including use of viruses and related structures as templates for nanowires and for arrays of inorganic materials of particular interest**
  - **To develop affordable manufacturing approaches to nanostructured bulk materials**

# Major Research Facilities and Instrumentation Acquisition

- **DoD Program Goals include:**
  - **To provide advanced nanoscience instrumentation via the Defense University Research Instrumentation Program (DURIP)**
  - **To provide DoD facilities and instrumentation capable of contributing to nanoscience research**

# Societal Dimensions

- **DoD Program Goals include:**
  - **To assure health and safety of war fighters utilizing future nanotechnology-based applications**
  - **To enable physicochemical characterization and toxicology for water, air and space environments**
  - **To sustain an investment strategy to enable a multidisciplinary education system capable of sustaining the skilled workforce needed to meet future defense needs**
  - **To assess, avoid and abate any adverse environmental or health impact from defense utilization of nanotechnology**

# Environmental Applications

- Nano Zero Valent Iron Restoration
- Nano Catalysts – “Greener” chemistry
- Air/water filtration – respirators, desalination
- Sensors of all types
- Energy
  - Fuel Cells,
  - Nanotube transmission lines
  - lighter, stronger materials

# Nanotechnology References

# Books

- **Over 500 references in Amazon.com for Nanotechnology books, including:**
  - ***Nano-Hype, The Truth Behind the Nanotechnology Buzz* – Berube (2006)**
  - ***Nanotechnology For Dummies* - Bookey/Boysen (2005)**

# Pertinent Web sites

- http:// www.nano.gov/
- http:// es.epa.gov/ncer/nano/
- http:// www.fda.gov/nanotechnology/
- http:// www.cdc.gov/niosh/topics/nanotech/
- http://www.becon2.nih.gov/nano.htm
- http://www.ostp.gov/pcast/pcast.html
- https://intranet.dodmeritinfo.net/index.cfm
- http://www.aepi.army.mil/
- http://www.wilsoncenter.org/index.cfm
- http://www.merid.org/nanodev/
- http://www.smalltimes.com/
- http://web.mit.edu/ISN/
- Several Others

# Recent On-Line ESOH Publications

- **Wilson Center "Managing the effects of Nanotechnology" http://nanotechproject.org**
- **EPA Nanotechnology White Paper http://es.epa.gov/ncer/nano/publications/index.html**
- **NIOSH, Approaches to Safe Nanotechnology: An Information Exchange with NIOSH http://www.cdc.gov/niosh/topics/nanotech/nano_exchange.html**

# 2006 Nanotech Conferences

- **Defense Applications Symposium, 1-4 May 2006, Virginia Beach, VA. (not ESOH) http://www.usasymposium.com/nano/**
- **Nanotoxicology, April 24 - 25, 2006, Hotel Marlowe, Cambridge, MA http://www.toxicology.org/ai/meet/conferences.asp**
- **International NT ESOH Conference, 4-8 Dec 2006, Cincinatti http://www.uc.edu/noehs/**
- **Several DC area meetings likely to be held by HQ EPA, others**
- **Over 200 Nanotechnology conferences for 2006 in Google search**